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VERIFICATION OF TRANSLATION

I, DAVID CLAYBERG

of 948 15th St., Ste. 4
Santa Monica, CA 90403-3134

declare that I am a professional translator well acquainted with both the German and English languages, and that the attached is an accurate translation, to the best of my knowledge and ability, of the accompanying German document.

Signature



David Clayberg

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Stator and Electric Machine

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Prior Art

5 A stator and electric machine according to the preamble to claim 1 are
already known from Japanese patent application 9-103052. To manufacture this
stator, first, individual sheet-metal lamina are stamped out and a particular
number of these sheet-metal lamina are stacked one on top of another until the
desired axial breadth of the core is achieved. These stacked sheet-metal lamina
10 constitute the stator core, which has teeth and grooves arranged parallel to one
another on one side in a manner that is customary for a stator. A pre-wound
core winding is produced, for example, in an approximately planar form and is
then inserted into the grooves of the for example essentially flat core. The
subassembly comprised of the core and core winding is then bent in a circular
15 fashion so as to yield a hollow, cylindrical stator. After the circular bending of the
subassembly comprised of the stator yoke and winding, the two ends are
connected to each other by welding. The welded connection between the two
ends is a multiply loaded joint whose specific embodiment cannot be gleaned
from any known technical teaching in the prior art.

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Advantages of the Present Invention

The stator according to the present invention, with the characteristics of
the main claim, has the advantage that by specifying the welding seam depth as
25 a function of the effective yoke height and a tolerance value for the welding
seam depth, a rule has been established that permits sure, reliable control of the
multiple influence parameters on the stator of an electric machine, on the one
hand so as to reliably prevent the welding seam from tearing open at the joint
after being welded and on the other hand, so as not to exert excessive,
30 disadvantageous influence for example on the electromagnetic properties of the
stator core at the joint. The rule provided for determining the welding seam

depth T_s , according to which the welding seam depth T_s is determined as a function of the yoke height H_{yoke} and a tolerance value ΔT_s in accordance with the following function

$$5 \quad T_s = 0.5 \text{mm} * (H_{yoke}/\text{mm} - 1) \pm \Delta T_s,$$

on the one hand gives the welding seam a sufficient strength to allow it, with a certain yoke height, to absorb the tensile forces occurring in the welding seam, but on the other hand, the welding seam is not too deep so that it does not exert

10 too excessive a negative influence on the magnetic properties at the welding point due to structural changes occurring in the yoke. One of these influences, for example, is the magnitude of undesirable eddy current losses that occur.

If the variable ΔT_s is equal to 1 mm, then this yields a secure welded

15 connection for the resulting minimum value and on the other hand, does not have an excessively deep welding seam that approaches the maximum value.

If the value ΔT_s is equal to 0.5 mm, then the welding seam quality can be reproduced with particular reliability.

20 If the welding seam depth T_s does not fall below a minimum value T_{smin} as a function of the yoke height H_{yoke} , where the minimum value T_{smin} is proportional to the yoke height H_{yoke} multiplied by the factor 3/40, then this yields a minimum strength of the welding seam for various yoke heights H_{yoke} .

25 If the yoke is embodied at the joint so that two teeth are disposed on the outside of the joint, then this yields the positive effect that on the one hand, the weld is disposed particularly far away from the yoke and on the other hand, even during the welding process, a relatively large degree of heat can be dissipated by 30 this outer tooth. Part of the heat therefore does not reach the yoke, which

results in less powerful influences being exerted on the electromagnetic properties of the yoke.

If the welding seam is disposed on a radial inside of the yoke so that the 5 joint is disposed at the tip of a tooth, then this reliably prevents vibration of these half teeth.

The welding seam is also disposed on at least one axial end of the stator. This reduces the magnetic noise at this point.

10 If the welding seam is a laser beam welding seam, then the embodiment of the weld permits the method for manufacturing the welding seam to be executed in a particularly reliable fashion. The welding parameters can be reliably adjusted, no additional application of welding material is made, and the 15 welding heat is significantly reduced in comparison to other methods for example deposit welding. Furthermore, the stator core is comprised of a material that has a carbon content of more than 0.1% (by mass).

20 The carbon content influences the brittleness of the welding seam and therefore its durability, for example when subjected to oscillatory loads.

Drawings

25 Exemplary embodiments of a stator and an electric machine according to the present invention are shown in the drawings.

Fig. 1 shows a stator according to a first exemplary embodiment,

Fig. 2 shows an end view of two exemplary embodiments of welding 30 seams in the joined stator core,

Fig. 3 is a graph depicting the function for the welding seam depth T_S for different parameters,

Figs. 4 and 5 show end views of two additional exemplary embodiments of

5 welding seams in the joined stator core, and

Fig. 6 is a depiction for determining the yoke height with a particular embodiment of the yoke.

10 Description

Fig. 1 shows a stator 10 of an electric machine. The stator 10 has an annular stator core 13 comprised of a stator core segment 14. The stator core 13 in this instance is comprised of a stator core segment 14 that is in turn 15 comprised of a multitude of stator lamellas 15. As in the prior art, the stator core 13 has inwardly oriented radial grooves 18 into which a stator winding 17 is inserted. This stator 10 is manufactured as described below. Individual, generally strip-shaped stator lamellas 15 are manufactured, which can extend in arcs or straight lines. The individual stator lamellas 15 are bundled so as to 20 produce a side that is provided with grooves 18 extending all the way through, into which the stator winding 17 is later inserted. After the insertion of the stator winding 17, this produces a subassembly comprised of the stator core 13 and the stator winding 17, which subassembly is then bent in a circular fashion so as to produce a cylindrical cavity in which the grooves 18 end. In order to preserve 25 this state, at least two ends of the stator core 13 that face each other after the circular bending are fixed in place by means of a welding seam 20. Otherwise, the stator 10 would gape open at the joint. It would be hardly possible to install it in a cylindrical bore of a housing.

30 Fig. 2 shows the joint 22. The figure shows each end 23 of the at least one stator core segment 14 on both sides of the joint 22. The two ends 23 are

embodied so that one partial tooth 24 rests against another partial tooth 24. The two partial teeth 24 function together as a whole tooth. The welding seam 20 is shown in cross section at the joint 22. In the radial direction, i.e. in the direction along the joint and/or the surface in which the partial teeth 24 rest against each 5 other, the welding seam 20 has a welding seam depth T_S . A yoke 26, i.e. a part of the stator core 13 and/or of a stator core segment 14, has a yoke height H_{yoke} between two teeth, for example between a partial tooth 24 and a partial tooth 25.

As a function of the yoke height H_{yoke} , the following function should apply 10 for the welding seam depth T_S :

$$T_S = 0.5\text{mm} * (H_{yoke}/\text{mm} - 1) \pm \Delta T_S,$$

The welding seam depth T_S is therefore a function of the yoke height H_{yoke} 15 and the tolerance value ΔT_S . The function for determining the welding seam depth T_S is therefore comprised of a base function f_B

$$f_B = 0.5 \text{ mm} * (H_{yoke}/\text{mm} - 1)$$

20 as a function of the yoke height H_{yoke} and the additional tolerance value ΔT_S . The variables H_{yoke} and ΔT_S are expressed in millimeters (mm); the value of $(H_{yoke}/\text{mm} - 1)$ is dimensionless. In the first iteration, ΔT_S corresponds to the variable ΔT_{S1} , which has a value of 1.0 mm. In the second iteration, ΔT_S corresponds to the variable ΔT_{S2} , which has a value of 0.5 mm.

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Fig. 3 shows the function for T_S for the various parameters, i.e. as a function of the yoke height and the tolerance value ΔT_S . Fig. 3 also shows the function of the minimal welding seam depth T_{Smin} , which is a function of the yoke height H_{yoke} . The function can be described by means of

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$$T_{Smin} = 3/40 * H_{yoke},$$

According to another exemplary embodiment, the welding seam 20 is disposed on the outside 30 of the yoke, on a tooth composed of two partial teeth 31, see Fig. 4. In another exemplary embodiment, the welding seam 20 is 5 disposed on a radial inside of at least one end 23 of the stator core segment 14, also see Fig. 2.

In order to reduce the magnetic noise, a welding seam 20 is disposed on an axial end of the stator 10 and/or stator core 13. This welding seam 20 can 10 also be provided on the axial end surface, see Fig. 5.

If a flute 35 is provided at the joint 22, then the effective yoke height H_{yoke} is not equivalent to the yoke height that has been described above. Here, the projected yoke height H_{yokeP} must be determined as an effective yoke height 15 H_{yoke} that serves as the basis for determining the required welding seam depth T_s according to the equation given at the beginning. To this end, the radial depth of the flute 35 is subtracted from the actual yoke height between two teeth 25, see Fig. 6. In this instance, the value of the projected yoke height H_{yokeP} must be used for the factor H_{yoke} .

20 In order to prevent the welding seam 20 from being too brittle and therefore unable to withstand anything more than small loads, the stator core 13 and/or the stator lamellas 15 is comprised of a ferrous material that has a carbon content of no more than 0.1% (by mass). Before the welding procedure is 25 executed, the stator winding 17 is mounted onto the stator core 13 at the joint 22 and then they are both bent together in a circular fashion.

In addition, the welding seam 20 has an ultimate tensile strength of 30 between 10 kN and 44 kN in the circumference direction of the yoke 26. Furthermore, the welding seam should have an ultimate tensile strength of between 20 kN and 36 kN at a depth of between 0.9 mm and 2.2 mm. At depths

between 1.1 mm and 1.8 mm, the ultimate tensile strength should be between 22 kN and 32 kN.